ELECTROLYSIS APPARATUS AND A METHOD OF HYDRODYNAMIC CAVITATION PROTECTION

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ELECTROLYSIS APPARATUS AND A METHOD OF HYDRODYNAMIC CAVITATION PROTECTION

ABSTRACT

Method of and apparatus for protecting the surfaces of hydrodynamic members subjected to a cavitating fluid environment such as seawater. A conductive metal insert is affixed to and electrically insulated from the surface of the member where cavitation damage is most likely to occur. A variable d-c voltage is connected between the metal insert (cathode) and the hydrodynamic member (anode). As the voltage is applied, a protective layer of hydrogen gas bubbles is formed over the conductive metal insert to thereby cushion the shock of the collapse of the cavitation voids.

BACKGROUND OF THE INVENTION

This invention relates to fluid reaction surfaces and more particularly to a method of an apparatus for protecting hydrodynamic surfaces susceptible of cavitation damage.

In the past, many attempts have been made to minimize

the damage to hydrodynamic members from the eroding and pitting effects of cavitation. Fabricating the member from costly cavitation-resistant materials has the disadvantage that, in most instances, only a small region of the mechanical surfaces of the members are susceptible to damage, thus, fabrication of the entire member from such materials is not justified. Moreover, no material has been found which is completely cavitation damage proof. Another means used to protect cavitating surfaces from damage is to weld a cavitation-resistant material into regions susceptible to damage. One disadvantage of this approach is that considerable skill is required to insure that the welding process does not alter desirable properties of the cavitation-resistant material because of high welding temperatures. Still another prior art protective measure is to coat surfaces subjected to cavitation with an elastomeric coating. Under intense cavitation, however, the coating has the tendency to peel away from the surface.

In U.S. Patent 2,803,428 air at atmospheric or higher pressure is introduced into the low pressure areas or cavities caused by the cavitation of the blades of a hydrodynamic turbine. The air introduced prevents

the collapse of the voids or cavities and provides an absorbent cushion to thereby reduce erosion of the blade. A disadvantage of this approach is the difficulty of insuring that the injected air is introduced precisely into the cavitating regions. Furthermore, an excess of air injection may result in an increase of cavitation intensity or an enlargement of the cavitation region which may produce a reduction in the efficiency of the hydrodynamic machinery.

SUMMARY OF THE INVENTION

In accordance with the present invention, a conductive metallic plate or insert is embedded in and electrically insulated from that portion or portions of the surface of a hydrodynamic member susceptible of cavitation. With the member immersed in water, a d-c voltage is applied between the insert (cathode) and the surface (anode) to electrolytically form a protective layer of hydrogen gas over the plate. By varying the voltage the degree of cavitation protection may be varied. The invention may be used to protect a wide variety of hydrodynamic surfaces such as for example hydraulic turbines, hydrofoils, hydrofoil struts, marine propellers and hydraulic ducting including inlets and

outlets. One advantage of the present invention is that gas is locally and precisely introduced into a region of known cavitation damage.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to protect hydrodynamic surfaces from cavitation damage by electrolytically forming a protective gas layer over the regions where cavitation damage is expected.

Another object of the invention is to provide a simple yet effective means to minimize cavitation damage which has wide applicability to a variety of hydrodynamic surfaces.

Other objects, advantages and novel features of the invention will appear from a reading from the following detailed description when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagramatic view showing the general concept of the present invention.

FIG. 2 is a cross-section view showing an embodiment of the invention as applied to a marine propeller.

DETAILED DESCRIPTION OF THE INVENTION

Referring now in detail to the drawings there is

illustrated in FIG. 1 a hydrodynamic member 10 the surface 12 of which is subjected to a cavitating fluid medium such as seawater. A conductive metal insert 14 is embedded in a cavity 16 formed in the surface 12 of the member 10. Location of the cavity 16 and insert 14 is established by determining the position of cavitation-susceptible surface regions of the member 10. The metal insert 14 is bonded to and electrically insulated from the member 10 by an epoxy adhesive 18 or other suitable material. The metal insert 14 may be fabricated of stainless steel or other conductive metal and coated with a thin film of noble metal such as platinum or other suitable conductive film to enhance its electrolytic qualities. The negative side of a d-c source 20 is electrically connected to the metal insert 14 to form the cathode. The positive side of source 20 is connected through a potentiometer 22 to the member 10 to form the anode. Upon application of voltage, hydrogen gas bubbles 24 are formed on the exterior surface of metal insert 14. The hydrogen gas fills the low pressure areas and voids caused by cavitation at the surface 12 to thereby cushion and absorb the energy of the pressure shocks resulting from the collapse of the cavitation voids.

The rate of hydrogen gas generation may be controlled by varying the setting of potentiometer 22.

In FIG. 2 there is shown a portion 26 of the hull of a marine vessel. A hollow shaft 28 extends through an opening 30 in the hull and is journaled in bearing 32. A marine propeller 34 is attached to one end of the shaft 28 in any conventional manner. The propeller blades 36 are each provided with metal inserts 38 embedded flush with the surfaces thereof in regions of expected cavitation damage. The metal inserts 38 are bonded to and insulated from the blades 36 by an epoxy adhesive 40. Wires 42 are electrically connected to the insert 38 and extend through conduits 44 formed in the blades 36 and into the interior of hollow shaft 28. Inside the hull of the vessel a slip ring 46 is arranged concentrically of the shaft 28 and is connected to the wires 42 in a manner well-known in the art. The wires 42 are electrically insulated from the blades 36 and shaft 28 and are connected through slip ring 46 to the negative side of a d-c source 48. The positive side of source 48 is connected through potentiometer 50 to another slip ring 52. Slip ring 52 is electrically connected to the shaft 28 and thus to the propeller 34. Application of the voltage to the

circuit causes current flow between the insert 38 and the blade 36 through the seawater medium. Since the insert 38 is at a negative potential, i.e. cathodic, hydrogen gas bubbles will be formed over the surface thereof by the well-known phenomenon of electrolysis. Variation of the setting of potentiometer 50 will cause a variation of the rate of generation of hydrogen gas at the surface of insert 38.

As will be apparent to those skilled in the art, the present invention may be advantageously utilized to protect many forms of hydrodynamic surfaces from cavitation damage. Likewise, the invention may be effectively used to minimize cavitation damage to surfaces exposed to other liquid mediums from which a gas may be electrolytically liberated with apparatus similar to that above-described.

As hereinabove described and illustrated in the accompanying drawings, the present invention provides a novel method of an apparatus for minimizing cavitation damage to hydrodynamic surfaces. [redacted]

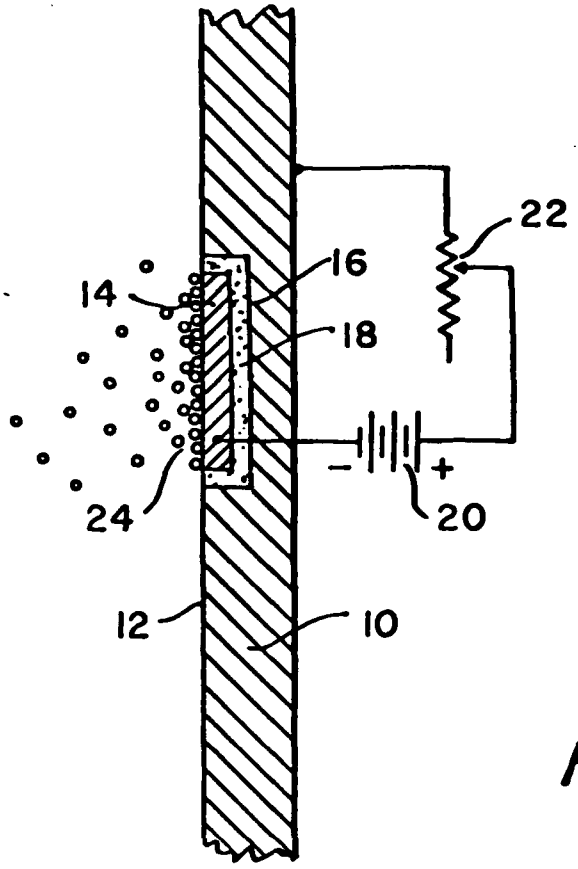

FIG. 1.

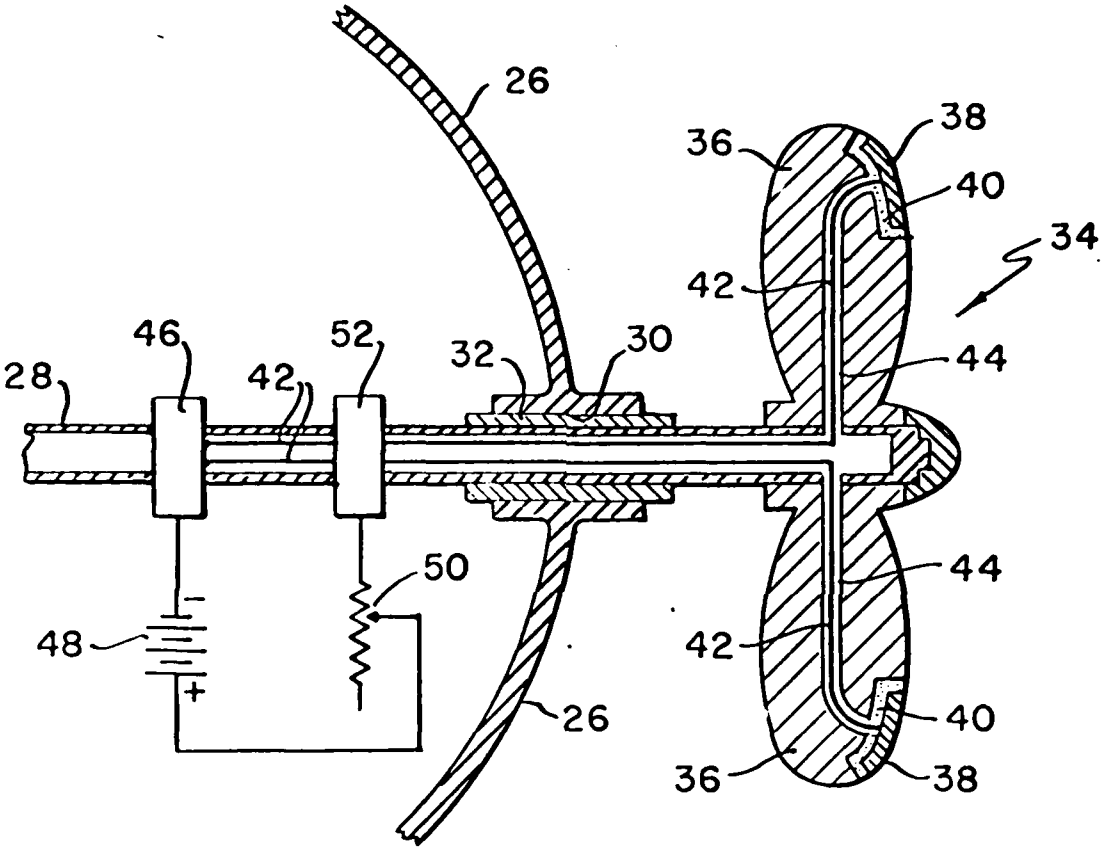

FIG. 2.